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INTER-COUNTY RIVER IMPROVEMENT

KING-PIERCE COUNTIES
P. O. BOX 548
SUMNER, WASHINGTON

April 8th, 1947

TO THE JOINT BOARD,
INTER COUNTY RIVER IMPROVEMENT COMMISSION,
KING AND PIERCE COUNTIES, WASHINGTON.

GENTLEMEN:

Att. Mr. Taylor M. Greene ,
Chairman King County Commissioners

For your information I am pleased to advise you that our Consulting Engineer, Mr. R. H. Thomson, is showing marked improvement since the serious illness that overtook him the last day of December.

At that time we were preparing our Annual Report for the year 1946, however Mr. Thomson's illness prevented him from participating in the final preparation of the report and I was compelled to complete it without his approval.

At this time Mr. Thomson is greatly improved and has prepared a supplemental report which he wishes to submit to you for your reference and approval.

You no doubt are aware that Mr. Thomson has given this work on the river his close attention for many years and is in position to arrive at definite conclusions that are of inestimable value to the progress of this Inter County River Improvement project.

We may truly hope that Mr. Thomson will continue to regain his health and yet be able to render the valuable service that he has for so many years.

Very truly yours,

F. H. Essig, C.E.

FHE/c

Copy to Pierce County

SUPPLEMENT TO THE CHIEF ENGINEER'S
ANNUAL REPORT FOR THE YEAR 1946

BY

R. H. THOMSON, CONSULTING ENGINEER

March 14, 1947

TO THE JOINT BOARD
INTER COUNTY RIVER IMPROVEMENT
KING AND PIERCE COUNTIES, WASHINGTON.

GENTLEMEN;

I am greatly disappointed that I was unable to sit in with Mr. Essig when he wrote the Annual Report. I spent the last day of December, 1946 along the river with Mr. Essig, examining the results of the December flood and planning with him the outline of our report. My return to the Inter County River Improvement office was to have been in a day or two, but when I was called on the morning of January 1st, I did not answer. The doctor declared I had suffered a "stroke" and that it would require more than a month to bring the body back to the state in which it stood when I had retired. "And don't try to come out of the shock in a day, " he said.

On my visit of December 31st, I was very proud of the results of the faithful work done by Mr. Essig the past four years during which time we have carried on the work and the studies made by Mr. Essig and myself.

In 1917 and 1919, heavy floods destroyed at least 20% of the work done to that date under the supervision of Professor Roberts, then Chief Engineer. After the 1919 flood I was sent down by the King County Commissioners to see what was the matter. After carefully examining the

wreckage from the mouth of White River Canyon, near Auburn, to Tacoma, I asked Professor Roberts to come with me and I would tell him what I proposed to tell the Commissioners.

I said, " You have tried to make a great showing of speed, and to do so you have left undone two of the most essential elements of safety. First; After trimming the banks to slope, you concreted the bank from somewhere near the top at such height as you found it, to within three or four feet from the bottom of the slope, but left a sand and gravel bank unprotected below, and in long stretches the top of the bank some distance below high water level.

" How far down do you think the concrete should be carried? " he asked.

I said, " To at least one foot below the river bed line, which some of your men speak of as the 'mud and gutter line' and some of the river bed outside the mud and gutter line should be covered either with heavy rock or with concrete blocks to prevent undercutting."

" All useless, " he said. "Rivers have been running in their own sand and gravel beds thousands of years, and any rock here or concrete will float. I will take you and prove it to you."

" All right, " I said, " I will go with you and look as soon as I have explained the second element of safety you omitted. I have said you carried the concrete to somewhere near the top; by 'the top', I mean the top of the bank."

" Well, now, these two things- what do you say they do?"

"What they do is this, as the flood rages, it undercuts the concrete lining and going much higher than the top of the concrete there being no bank above, it quickly begins crawling down behind the concrete

slab. The footing under the concrete gone, the water from the flooded bank flowing down behind, the concrete is carried out into the river and as a result you have lost over a hundred thousand dollars worth of work."

He showed me the "floating rock and concrete." The Northern Pacific Railroad had brought the firmest rock from Veasie and had put it around their bridge pier at White River Crossing. The piers contracted the channel width and the current was thereby greatly increased and a few rock had been carried a few hundred feet down stream. I argued how much more sand and gravel would White River current generally take up and carry away, if not protected. Going up to the Auburn Dam, he assured me that over 700 feet of materials had been carried away from under the base of the concrete dam, which was left standing on piles at an elevation of over seven feet above the river bed level as left by the flood, thus threatening to throw the river right back to its old channel, from which the flood had moved it. He told me that he proposed to fill the space underneath the original base of the Auburn Dam where it had been undercut, with boulders and cobblestone well intermixed with concrete, and when that was set to carry out over the bed of the river a concrete apron over which the water would have to flow and by flowing that way, entirely protect the newly supported section of the dam. He here showed that the open bank below the concrete required protecting although violently denying the need all along the bank.

We then went down the river, examining the west or right bank from the Dam to the Northern Pacific Bridge and discussing the difficulty of sustaining that bank except by the use of heavy rock as riprap. He said that rock as riprap was no good; he would make concrete blocks.

After several days of discussion and I had written my report containing practically the conclusions herein set forth, I left him with injunctions to study all possibilities of undercutting and its prevention and of the over topping of concrete. He regarded my idea of caution as rather foolish and it is presently evident that he did not follow them because when in the years 1933 and 1934 the flood, possibly a little heavier than that in 1917 and 1919, tearing through the river channel destroying the protective work, that to replace cost over $200,000, nearly all of the damage was the result of failure to study protection from undercutting, to raise the bank by deposits of earth and to carry up the concrete until it is well above any overflow line.

Some four years ago, coming on the work with Mr. Essig, I went with him over the river and told him I thought we ought to agree on some sentences or statements which would primarily represent what we believed we should study continually along the river. Without waiting for a suggestion from me, Mr. Essig spoke up and said, " It seems to me that when we come to the river that at every point as we look at the banks, we should inquire, 'What do I see at this bank which may indicate danger of undercutting or danger of over flow?' I think those two things are the major points to study."

Inasmuch as that came from him in as perfect shape as I could have stated it, I felt sure we were going to work together and put the river in a shape to withstand the flood; but there was very much to be done. So, in that faith, I turned and shook Mr. Essig's hand and thanked him for saying better than I could say it, what we were to do. During these past four years, day by day, we have continued on that formula: studying the undercutting and the overtopping.

To do this thing Mr. Essig has been very faithful, following what I have been speaking of as the high water line of the river thruout its course down to the Tacoma City limits, he has diligently observed the depth of the channel at the footing of the concrete and as rapidly as they could be found he has transported rock from the Pierce County quarry and filled in where there has been a scour underneath the revetment. The scour, sometimes 15 or 16 feet deep and 100 to 200 feet long which if it had remained until high water would have taken that length of concrete revetment out, regardless of any overflow. In all places where we believed an overflow might occur, he hauled a very proper form of earth and has raised the bank so that the bank all along is several feet above the elevation of high water as determined by United States Engineers to be found on the opposite side of the river.

Now in this December flood of 1946, we have excaped with almost negligible damage thruout the main part of the river. We have learned, however, that the bed of this river is very unequal in quality of material. It is composed of drift which has been brought down by the rivers and has been made of uneven deposits, running along for a short distance, a very fine silt, then that will be followed by a material largely composed of gravel which acts as though it has been to some extent mixed with clay. The silt section will pick up with the moving water and move on, whereas the sand, gravel and clay section tends to remain fairly firm. The silt section does not necessarily reach from one side entirely to the other, but it will pocket wherever it is found to be, and when that is under the edge or line of the revetment, out goes this fine sand and a deep scour remains, which must be quickly filled.

There are, of course, other things connected with the river which are difficult to handle. The rate of grade on which the river goes as it comes out of the White River Canyon is that of 40 feet to the mile. This gives a tremendous velocity and it continues for about a mile and a quarter down stream. When it reached one of the earlier banks left by the discharge from the river many years ago when everything was flowing toward the sea and that coming from White River and Green River apparently joined in flowing toward Tacoma instead of continuing on due west, the flood in its haste turned to the south and, flowing along the flattened area, it flowed at a grade of only about 4 feet per mile, as compared with 40 feet per mile. The difference in rate of grade, of course, affected the velocity so that about a half mile below the point of the Northern Pacific Bridge, many rock which had been carried that far from the Canyon mouth were dropped by the river because of the decreased velocity to carry them farther and there for a time these rock formed an island and caused the water to flow on both sides, both right and left, there apparently being no limit to the quantity. These islands caused a constriction in the normal stream regimen and flowing through the side narrows so made greatly accelerating the speed, these side washes spread away out so they moved all of the surface land from over a thousand acres, and carrying many thousand cubic yards of earth and deposited it over the plain, in some places where there were sinks deposits of five or six feet of sand occurred, decreasing far away to where the deposit was less than a foot.

Now the question of handling and protecting the river channel from the mouth of the Canyon down stream to the Northern Pacific Bridge had never been fully determined. Numerous methods have been attempted but to date none have proven satisfactory. What we want is to find a seam of very heavy rock, rock so heavy that the velocity of water flowing on a grade of

40 feet per mile cannot move it. We have taken some of the heaviest rock that we have been able to find in Pierce County, blocks running 1½ to 3 feet in thickness and containing a total of 4 to 4½ cubic yards, and have deposited them as carefully as we could near the mouth of the canyon, but when the river coming on a grade at 40 feet to the mile, the velocity of the water is such it overcomes the specific gravity of the rock and while it plays upon it, causing it to move with the current. During 1942 when Mr. Walter was Chief Engineer, I agreed with him what we needed and should use along this section of the river from the mouth of the White River Gorge down to the Northern Pacific Bridge is rock of such specific gravity that it would overcome by weight the projectile force of water moving on a grade of 40 feet to the mile. Mr. Walter said he believed there was some deposits of granite which would have that weight. We therefore drove up to the Electron quarry and gathered a few samples of such rock as was in evidence there. Mr. Walter kindly took them, intending to have them tested to find their real specific gravity. Unfortunately, he passed away before that was done. We are still looking for rock of sufficient weight to resist the violence of the force of the flood along the river between the mouth of the canyon and the Northern Pacific Bridge.

We fully appreciate however, that simply having a sufficiently heavy rock does not provide a complete solution to this problem. The way to use or place the rock is quite important. When it is placed as a long narrow strip, say four or five feet wide, out from the foot of the revetment the current tends to undercut first the outer rock, then the next and so on until the whole rock strip or floor is gone, either carried away by the force of the current or submerged into the bed of the river and a deep scour is made, how deep the scour pocket will develope cannot be predetermined as it varies with the location, no two places being alike.

Last summer Mr. Essig located a portion of the river bank on a long tangent, carefully examining the river bed there to find that the bank consisted of a fine sand deposit. He therefore built a rock floor over six feet out and placed rock upon the slope to produce a well revetted bank. He felt he had secured a long piece of bank that should resist the erosive action of the stream. When the waters subsided after the December 1946 floods he visited this especially treated section and was sorely disappointed that he could not find any of the rock revetment. Instead there was a wide scour of over 150 feet in length with depth unknown. During the low water period he will try and locate the lost rock and find the depth to which it gravitated or how far down stream it moved. In an effort to overcome this condition he will try placing low triangular groins in groups, one set say every 50 feet, one set say every 60 feet and one set at greater distance, there will be two groins per set. The size of each set of groins will vary as conditions may indicate. I am very heartily in favor of the experient, but expect many combinations of size, spacing and height of groins will have to be tried before we secure the final answer to our problem. When this wins we will publish our findings in the Engineering Journals.

Respectfully submitted,

R. H. Thomson

H. H. Thomson,
Consulting Engineer
Inter County River Improvement.